

FIGURE 8. 350Ω Bridge With $\times 10$ Preamplifier.

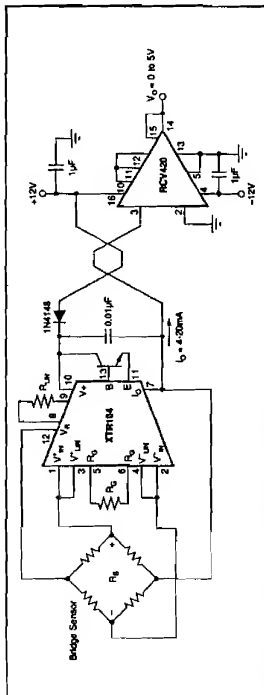


FIGURE 9. $\pm 12\text{V}$ Powered Transmitter/Receiver Loop.

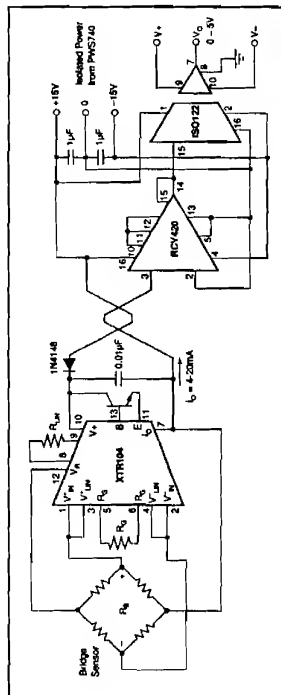


FIGURE 10. Isolated Transmitter/Receiver Loop.



XTR110



PRECISION VOLTAGE-TO-CURRENT CONVERTER/TRANSMITTER

FEATURES

- 4mA to 20mA TRANSMITTER
- SELECTABLE INPUT/OUTPUT RANGES: 0V to +5V, 0V to +10V Inputs 0mA to 20mA, 5mA to 25mA Outputs Other Ranges
- 0.005% MAX NONLINEARITY, 14 BIT
- PRECISION $\pm 10\text{V}$ REFERENCE OUTPUT
- SINGLE SUPPLY OPERATION
- WIDE SUPPLY RANGE: 13.5V to 40V

APPLICATIONS

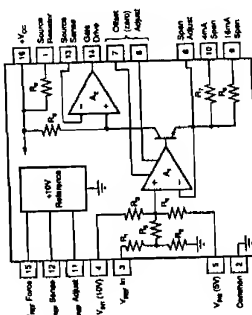
- INDUSTRIAL PROCESS CONTROL
- PRESSURE/TEMPERATURE TRANSMITTERS
- CURRENT-MODE BRIDGE EXCITATION
- GROUNDED TRANSDUCER CIRCUITS
- CURRENT SOURCE REFERENCE FOR DATA ACQUISITION
- PROGRAMMABLE CURRENT SOURCE FOR TEST EQUIPMENT
- POWER PLANT/ENERGY SYSTEM MONITORING

DESCRIPTION

The XTR110 is a precision voltage-to-current converter designed for analog signal transmission. It accepts inputs of 0 to 5V or 0 to 10V and can be connected for outputs of 4 to 20mA, 0 to 20mA, 5 to 25mA and many other commonly used ranges.

A precision on-chip metal film resistor network provides input scaling and current offsetting. An internal 10V voltage reference can be used to drive external circuitry.

The XTR110 is available in 16-pin plastic DIP, ceramic DIP and SOIL-16 surface-mount packages. Commercial and industrial temperature range models are available.



For Immediate Assistance, Contact Your Local Salesperson

SPECIFICATIONS

ELECTRICAL

At $T_A = +25^\circ\text{C}$ and $V_{CC} = +24\text{V}$ and $R_L = 250\Omega$, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
TRANSFER CHARACTERISTICS					
Input Voltage, V_{in}		0			V
Input Current, I_{in}		0			mA
Output Voltage, V_{out}		0			V
Output Current, I_{out}		0			mA
Distortion					%
Offset Current, I_{os}		0			mA
Offset Voltage, V_{os}		0			mV
Input Resistance					k Ω
Dynamic Response					ns
Slew Rate					V/ μs
Output Voltage					V
Output Current					mA
Power Supply					V
Temperature					°C
Operating AG, BG, AG					°C

* Specifications apply to AG/BG grades. ** Specifications apply to the range of R_L shown in Typical Performance Curves. NOTES: (1) Including internal inductance. (2) Span is the change in output current resulting from a full scale change in input signal. (3) Within compliance range limited by $(V_{CC} - 2V)$. V_{CC} required for linear operation of the FET. (4) For V_{out} adjustment circuit see Figure 3. (5) Unit may be damaged. See section, "Input Voltage Protection".

ABSOLUTE MAXIMUM RATINGS

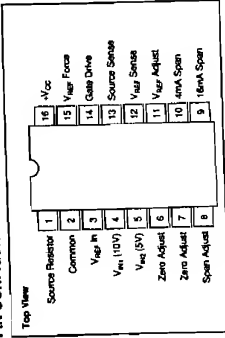
Power Supply, V_{CC}	30V
Input Voltage, V_{in}	30V
Storage Temperature Range	-55°C to $+125^\circ\text{C}$
Operating Temperature Range	-55°C to $+85^\circ\text{C}$
Lead Temperature (soldering, 100 G, P)	300°C
Output Short-Circuit Duration, Gate Drive	Continuous to common and V_{CC} and V_{EE} for 100 G, P
Output Current Limiting, Internal 500 Resistor	40mA

ELECTROSTATIC DISCHARGE SENSITIVITY

Any integral circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet published specifications.

PIN CONFIGURATION

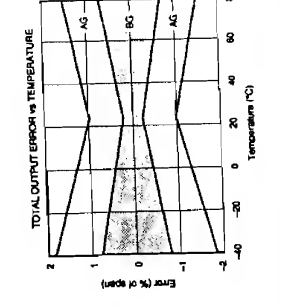
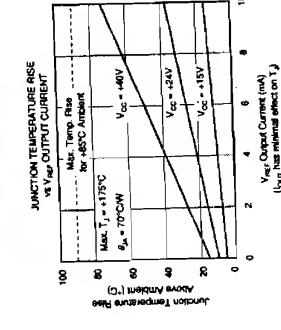
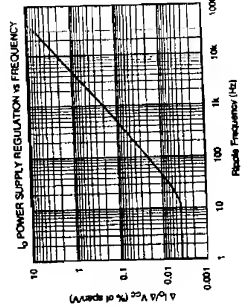
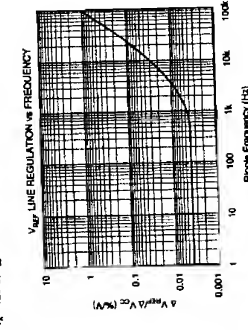


ORDERING INFORMATION

MODEL	PACKAGE	TEMPERATURE RANGE
XTR110AG	16-Pin Ceramic DIP	-40°C to $+85^\circ\text{C}$
XTR110BG	16-Pin Ceramic DIP	-40°C to $+85^\circ\text{C}$
XTR110P	16-Pin Plastic DIP	0°C to $+70^\circ\text{C}$
XTR110K	16-Pin Plastic DIP	0°C to $+70^\circ\text{C}$
XTR110KU	16-Pin Surface-Mount	0°C to $+70^\circ\text{C}$

TYPICAL PERFORMANCE CURVES

$T_A = +25^\circ\text{C}$, $V_{CC} = 24\text{VDC}$, $R_L = 250\Omega$, unless otherwise noted.



Or, Call Customer Service at 1-800-540-6132 (USA Only)

PACKAGE INFORMATION⁽¹⁾

MODEL	PACKAGE	PACKAGE DRAWING NUMBER
XTR110AG	16-Pin Ceramic DIP	109
XTR110BG	16-Pin Ceramic DIP	109
XTR110P	16-Pin Plastic DIP	110
XTR110KU	16-Pin Surface-Mount	211

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

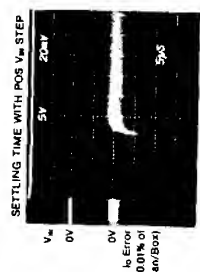
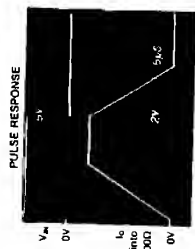
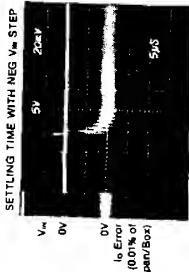
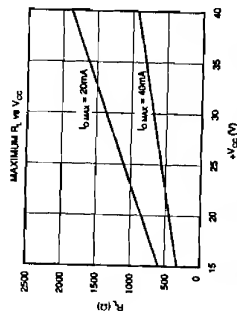
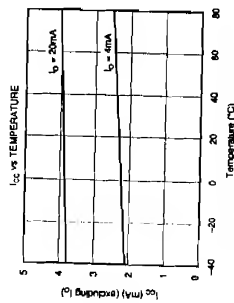
XTR110

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INSTRUMENTATION AMPLIFIERS

TYPICAL PERFORMANCE CURVES (CONT)

$T_A = +25^\circ\text{C}$, $V_{EE} = 24\text{VDC}$, $R_1 = 250\Omega$, unless otherwise noted.



APPLICATIONS INFORMATION

Figure 1 shows the basic connections required for 0 to 10V input and 4 to 20mA output. Other input voltage and output current ranges require changes in connections of pins 3, 4, 5, 9 and 10 as shown in the table of Figure 1.

The complete transfer function of the XTR110 is:

$$I_0 = \frac{10 \left[\frac{(V_{REF IN})}{16} + \frac{(V_{IN1})}{4} + \frac{(V_{IN2})}{2} \right]}{R_{SQW}} \quad (1)$$

R_{SPAN} is the internal 50 Ω resistor, R_p when connected as shown in Figure 1. An external R_{SPAN} can be connected for different output current ranges as described later.

EXTERNAL TRANSISTOR

An external pass transistor, Q_{EXT} , is required as shown in Figure 1. This transistor conducts the output signal current. A P-channel MOSFET transistor is recommended. It must have a voltage rating equal or greater than the maximum power supply voltage. Various recommended types are shown in Table 1.

TABLE I. Available P-Channel MOSFETs.

MANUFACTURER	PART NO.	$B_{\text{sat}}^{\text{m}}$	$B_{\text{sat}}^{\text{m}}$	PACKAGE
Fairchild	27P1305A	40V	20V	TO-18
	27P1306A	40V	20V	TO-18
	27P1306A	80V	20V	TO-18
	27P1305B	80V	20V	TO-18
International Rectifier	IRF9513	80V	20V	TO-220
Motoco	IRL1P08	80V	20V	TO-18
PCA	IRL1P08	80V	20V	TO-18
Siliconix	VM0300B	30V	40V	TO-18
(preferred)	VM0300C	30V	40V	TO-18
	VM0300D	30V	40V	TO-18
	VM0300E	30V	40V	TO-18
	VM0300L	80V	40V	TO-18
Supertex	VM0604B	80V	40V	TO-227
	VF134M2	40V	20V	TO-220
	VF1304M3	40V	20V	TO-18
	VF1304M2	40V	20V	TO-18
	VF1304M2	40V	20V	TO-18
	VF1304M2	80V	20V	TO-18

NOTE: 1. $B_{\text{sat}}^{\text{m}}$ —Breakdown voltage. $B_{\text{sat}}^{\text{m}}$ —Gate-source breakdown voltage.

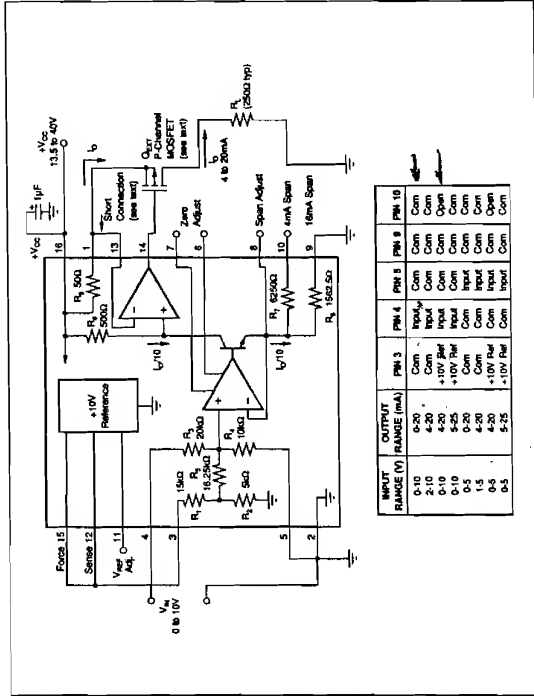


FIGURE 1. Basic Circuit Connection.

If the supply voltage, $+V_{CC}$, exceeds the gate-to-source breakdown voltage of Q_{out} , the output connection (drain of Q_{out}) is broken. Q_{out} could fail. If the gate-to-source breakdown voltage is lower than $+V_{CC}$, Q_{out} can be protected with a 12V zener diode connected from gate to source.

Two PNP discrete transistors (Darlington-connected) can be used for Q_{out} —see Figure 2. Note that an additional capacitor is required for stability. Integrated Darlington transistors are not recommended because their internal base-emitter resistors cause excessive error.

TRANSISTOR DISSIPATION

Maximum power dissipation of Q_{out} depends on the power supply voltage and full-scale output current. Assuming that the load resistance is low, the power dissipated by Q_{out} is:

$$P_{max} = (+V_{CC}) I_{fs}$$

The transistor type and heat sinking must be chosen according to the maximum power dissipation to prevent overheating. See Table II for general recommendations.

PACKAGE TYPE	ALLOWABLE POWER DISSIPATION
TO-18	Lowest: Use minimum supply and 25°C .
TO-18	Accepted: Trace of supply and temperature.
TO-18	Accepted: Trace of supply and temperature.
TO-220	Accepted: Trace of supply and temperature.
TO-3	Use for hermetic package is required.

TABLE II. External Transistor Package Type and Dissipation.

INPUT VOLTAGE RANGE

The internal op amp A_1 can be damaged if its non-inverting input (an internal node) is pulled more than 0.5V below common (0V). This could occur if input pins 3, 4 or 5 were driven with an op amp whose output could swing negative under abnormal conditions. The voltage at the input of A_1 is:

$$V_{in} = \frac{(V_{ref}/2) + (V_{in})}{4} + \frac{(V_{ref})}{2} \quad (3)$$

This voltage should not be allowed to go more negative than -0.5V. If necessary, a clamp diode can be connected from the negative-going input to common to clamp the input voltage.

COMMON (Ground)

Careful attention should be directed toward proper connection of the common (grounds). All commons should be joined at one point as close to pin 2 of the XTR110 as possible. The exception is the I_{out} return. It can be returned to any point where it will not modulate the common at pin 2.

VOLTAGE REFERENCE

The reference voltage is accurately regulated at pin 12 (V_{ref} sense). To preserve accuracy, any load including pin 3

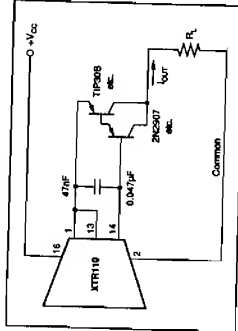


FIGURE 2. Q_{out} Using PNP Transistors.

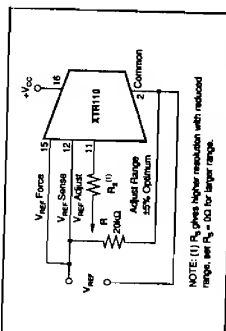


FIGURE 3. Optional Adjustment of Reference Voltage.

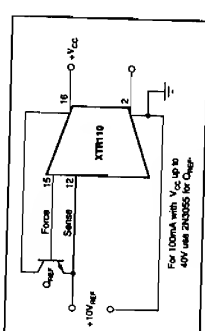


FIGURE 4. Increasing Reference Current Drive.

should be connected to this point. The circuit in Figure 3 shows adjustment of the voltage reference.

The current drive capability of the XTR110's internal reference is 10mA. This can be extended if desired by adding an external PNP transistor shown in Figure 4.

OFFSET (ZERO) ADJUSTMENT

The offset current can be adjusted by using the potentiometer R_1 shown in Figure 5. Set the input voltage to zero and then adjust R_1 to give 4mA at the output. For spans

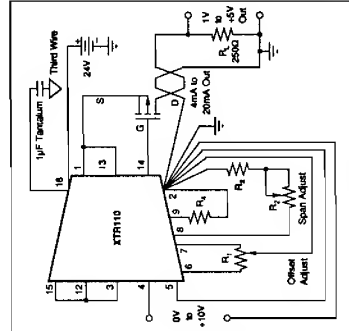


FIGURE 5. Offset and Span Adjustment Circuit for 0V to +10V Input, 4mA to 20mA Output.

starting at 0mA, the following special procedure is recommended: set the input to a small nonzero value and then adjust R_1 to the proper output current. When the input is zero the output will be zero. Figures 6 and 7 show graphically how offset is adjusted.

SPAN ADJUSTMENT

The span is adjusted at the full-scale output current using the potentiometer, R_2 , shown in Figure 5. This adjustment is interactive with the offset adjustment, and a few iterations may be necessary. For the circuit shown, set the input voltage to +10V full scale and adjust R_2 to give 20mA full-scale output. Figures 6 and 7 show graphically how span is adjusted.

The values of R_1 , R_2 , and R_3 for adjusting the span are determined as follows: choose R_1 in series to slightly decrease the span; then choose R_2 and R_3 to increase the span to be adjustable about the center value.

LOW TEMPERATURE COEFFICIENT OPERATION

Although the precision current in the XTR110 track within $1\text{ppm}/^{\circ}\text{C}$, the output current depends upon the absolute temperature coefficient (TC) of any one of the resistors, R_1 , R_2 , and R_3 . Since the absolute TC of the output current can have $20\text{ppm}/^{\circ}\text{C}$ maximum, the TC of the output current can have $20\text{ppm}/^{\circ}\text{C}$ drift. For low TC operation, zero TC resistors can be substituted for either the span resistors (R_2 or R_3) or for the source resistor (R_1) but not both.

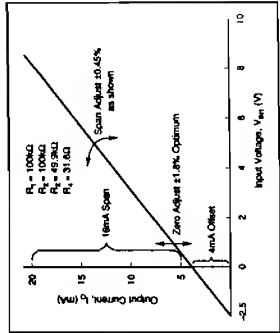


FIGURE 6. Zero and Span of 0V to +10V Input, 4mA to 20mA Output Configuration (see Figure 5).

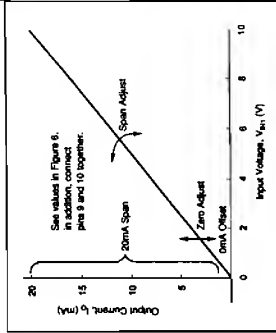


FIGURE 7. Zero and Span of 0V to +10V, 0mA to 20mA Output Configuration (see Figure 5).

EXTENDED SPAN

For spans beyond 40mA, the internal 500 resistor (R_1) may be replaced by an external resistor connected between pins 13 and 16.

Its value can be calculated as follows:

$$R_{span} = R_1 (Span_{max}/Span_{nom})$$

Since the internal thin-film resistors have a 20% absolute value tolerance, measure R_1 before determining the final value of R_{span} . Self-heating of R_{span} can cause nonlinearities. Therefore, choose one with a low TC and adequate power rating. See Figure 10 for application.

TYPICAL APPLICATIONS

The XTR110 is ideal for a variety of applications requiring high noise immunity current-mode signal transmission. The precision +10V reference can be used to excite bridges and transducers. Selectable ranges make it very useful as a precision programmable current source. The compact design XTR110.

and low price of the XTR110 allow versatility with a minimum of external components and design engineering expense.

Figures 8 through 10 show typical applications of the XTR110.

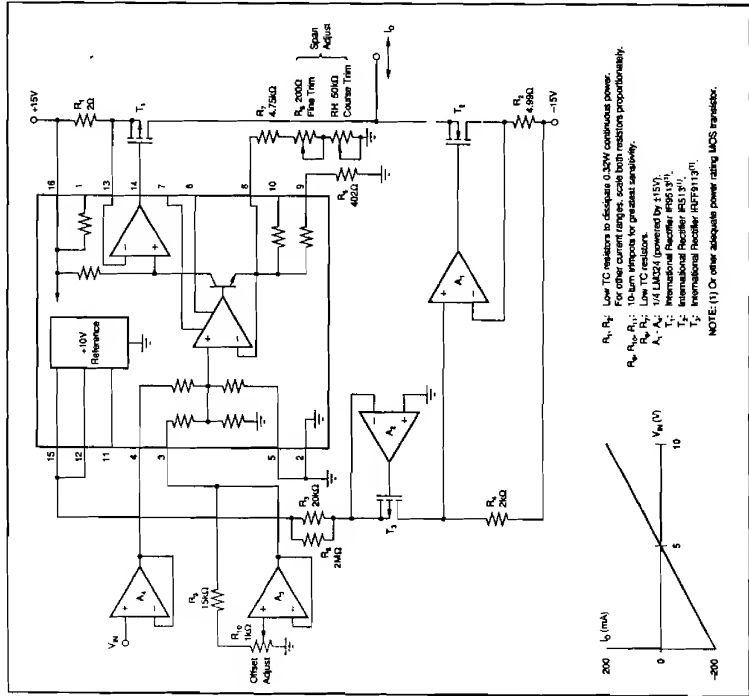


FIGURE 8. ±200mA Current Pump.

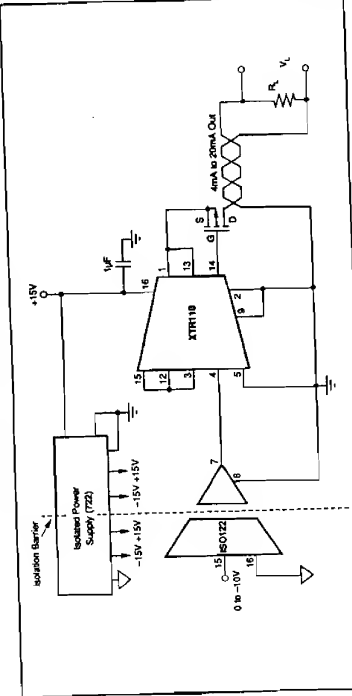


FIGURE 9. Isolated 4mA to 20mA Channel.

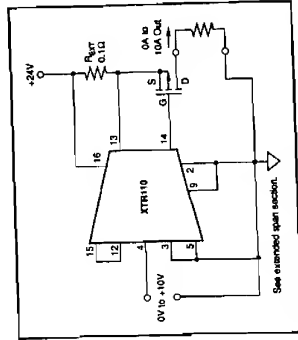


FIGURE 10. 0A to 10A Output Voltage-to-Current Converter.